17. SEVERE WINTER WEATHER

17.1 HAZARD PROFILE

17.1.1 Hazard Description

Severe winter weather is any storm system that produces significant snowfall, ice, and/or freezing rain, typically accompanied by high winds. Some severe winter weather events are large enough to immobilize an entire region, while others may only affect a single community. Affected communities experience cold temperatures, flooding, closed or blocked roadways, downed utility lines, and power outages. The aftermath can impact a community or region for days, weeks, or even months, For this HMP, the severe winter weather hazard includes heavy snow, blizzards, and ice storms (sleet and freezing rain).

Heavy Snow

A heavy snowstorm is defined as a snowstorm with accumulations of 4 inches or more of snow in a 6-hour period, or 6 inches or more of snow in a 12-hour period (NWS 2009). The quantity of precipitation varies by elevation; mountainous areas have higher thresholds for defining heavy snowfall.

Snow is precipitation in the form of ice crystals (NSIDC 2023). It originates in clouds when temperatures are below the freezing point (32 °F). There, water vapor from the air condenses directly into ice without going through the liquid stage. Once an ice crystal has formed, it absorbs and freezes additional water vapor from the surrounding air, growing into snow crystals or snow pellets, which then fall to the earth. Snowflakes are clusters of ice crystals that form from a cloud. Snow pellets are opaque ice particles that form when ice crystals fall through super-cooled cloud droplets that are below freezing but remain a liquid. The cloud droplets then freeze to the crystals.

Blizzards

A blizzard is a winter snowstorm with sustained or frequent wind gusts of 35 miles per hour (mph) or more, accompanied by falling or blowing snow reducing visibility to or below a quarter mile (NWS n.d.). These conditions must be predominant over a three-hour period. Extremely cold temperatures are often associated with blizzard conditions but are not a formal part of the definition. Associated risks significantly increase when temperatures are below 20 °F. A severe blizzard is categorized as having temperatures near or below 10 °F, winds exceeding 45 mph, and visibility reduced by snow to near zero.

Storm systems powerful enough to cause blizzards usually form when the jet stream dips far to the south, allowing cold air from the north to clash with warm, moister air from the south. Blizzard conditions often develop on the northwest side of an intense storm system. The difference between the lower pressure in the storm and the higher pressure to the west creates a tight pressure gradient, resulting in strong winds and extreme conditions caused by the blowing snow (NWS n.d.).

Ice Storms

An ice storm consists of damaging accumulations of ice during freezing rain situations. Significant accumulations of ice pull down trees and utility lines, resulting in loss of power and communications. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually 0.25 inches or greater (National Weather Service 2009). Ice storms can consist of precipitation in the following forms:

- **Sleet** is made up of drops of rain that freeze into ice as they fall. They are usually smaller than 0.30 inch in diameter (NSIDC 2013). A sleet storm involves significant accumulations of solid pellets, which form from the freezing of raindrops or partially melted snowflakes, causing slippery surfaces that pose a hazard to pedestrians and motorists (NWS 2009).
- **Freezing Rain** occurs when rain falls into areas that are below freezing and turns to ice on the ground and other surfaces. For this to occur, ground-level temperatures must be colder than temperatures aloft. Freezing rain can also occur when the air temperature is slightly above freezing but the surface that the rain lands upon is still below freezing from prior cold air temperatures (NWS 2009).

17.1.2 Location

Heavy Snow

The trajectory of a snow storm's center determines the intensity and the duration of snowfall over the state. The southeastern third of Sussex County receives slightly less snowfall than the rest of the County, most likely due to the coastal influences moderating temperatures slightly. Snow may fall from about October 15 to April 30 in the Northern Highlands counties, which includes Sussex (Rutgers University 2021).

Blizzards

A blizzard's trajectory—whether it passes close to the New Jersey coast or at a distance—largely determines which portion of the County receives the heaviest amount of snow. Severe winter weather events tend to have the heaviest snowfall within a 150-mile-wide swath to the northwest of what are generally southwest to northeast moving storms.

Ice Storms

All regions of New Jersey are subject to ice storms. The distribution of ice storms often coincides with general distribution of snow within several zones in the state. As a coastal storm moves northeastward offshore, a cold rain may be falling over the southern portion of the state, freezing rain over the central region, and snow over the northern counties. A locality's distance from the passing storm center is often the crucial factor in determining the temperature and type of precipitation during severe winter weather (Changnon and Karl 2003).

17.1.3 Extent

The magnitude or severity of severe winter weather depends on snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, time of occurrence during the day, and time of season. In Sussex County the average yearly snowfall is between 40 and 50 inches, with significant variation from year to year. February is the month when maximum accumulations on the ground are usually reached.

NOAA's National Climatic Data Center (NCDC) produces the Regional Snowfall Index (RSI) for significant snowstorms across the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from Category 1 to 5, as listed in Table 17-1. RSI is based on the spatial extent of the storm, the amount of snowfall, and the affected population. The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA NCEI 2023).

Table 17-1. RSI Ranking Categories

Category	Description	RSI Value
1	Notable	1-3
2	Significant	3-6
3	Major	6-10
4	Crippling	10-18
5	Extreme	18.0+

Source: NOAA-NCEI 2023

Sleet accumulation is measured and tracked in a method similar to snow. Ice accumulation is determined by taking the average from the thickest and thinnest portions of ice on a sample used for measurement. Ice does not coat the surface of objects evenly, as gravity typically forces rainwater to the underside of an object before it freezes. Wind can also force rainwater downward prior to freezing, resulting in a thicker coating of ice on one side of the object than the other side (NWS n.d.).

The NWS operates a widespread network of observing systems that feed into computer models to forecast weather for the upcoming hours and days. NWS meteorologists analyze the model output and disseminate forecasts (NWS n.d.). The NWS issues alerts to help people anticipate approaching storms:

- A ***winter storm watch*** is issued when severe winter conditions (heavy snow, ice, etc.) may affect a certain area, but its occurrence, location, and timing are uncertain. A watch is issued to provide 24 to 72 hours of notice of the possibility of severe winter weather.
- A ***winter storm warning*** is issued when hazardous winter weather, in the form of heavy snow, heavy freezing rain, or heavy sleet, is imminent or occurring. A warning is usually issued 12 to 24 hours before the event is expected to begin.
- A ***winter weather advisory*** is issued when a hazardous winter weather event is occurring, is imminent, or has a greater than 80 percent chance of occurrence. Advisories are used to inform people that winter weather conditions are expected to cause significant inconveniences and that conditions may be hazardous. These conditions may refer to sleet, freezing rain, or ice storms, in addition to snow events (NWS n.d.).
- NWS may issue a ***blizzard warning*** when snow and strong winds combine to produce the potential for blinding snow, deep drifts, and wind chill (NWS 2009).

Previous Occurrences

FEMA Major Disaster and Emergency Declarations

Sussex County has been included in four major disaster (DR) or emergency (EM) declarations for severe winter weather-related events (FEMA 2024), as listed in Table 17-2.

USDA Declarations

The U.S. Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans from the U.S. Department of Agriculture (USDA) to producers suffering losses in those counties and in contiguous counties. Since the previous Sussex County HMP, the County was not included in any USDA severe winter weather-related agricultural disaster declarations (USDA 2024).

Table 17-2. FEMA Declarations for Severe Winter Weather Events in Sussex County (1954 to 2024)

Event Date	Declaration Date	Declaration Number	Description
March 13-17, 1993	March 17, 1993	EM-3106	Severe Blizzard
January 7-12, 1996	January 13, 1996	DR-1088	Blizzard of 96 (Severe Snowstorm)
February 16-17, 2003	March 20, 2003	EM-3181	Snow
January 31 – February 2, 2021	April 28, 2021	DR-4597	Severe Winter Storm and Snowstorm

Sources: FEMA 2024

Previous Events

Known hazard events that impacted Sussex County between January 2020 and June 2024 are listed in Table 17-3. For events prior to 2020, refer to the 2021 Sussex County HMP.

Table 17-3. Severe Winter Weather Events in Sussex County (2020 to 2024)

Event Date	FEMA Declaration or State Proclamation Number	Sussex County included in declaration?	Location Impacted	Description
January 18, 2020	N/A	N/A	Sussex County	Up to 3 inches of snow was observed throughout the County with light ice accumulation.
January 25, 2020	N/A	N/A	Sussex County	Light ice accumulation was seen throughout the County, especially in high elevation areas at High Point.
February 6, 2020	N/A	N/A	Sussex County	Freezing rain was seen across the County. Sussex Airport Automated Surface Observing Systems (ASOS) reported 0.03 inches of ice accretion.
December 16, 2020	N/A	N/A	Sussex County	Heavy snow was seen across the County ranging from 8 to 12 inches. 12.3 inches of snowfall was recorded at COOP side in Highland Lakes.
January 1, 2021	N/A	N/A	Sussex County	Sleet and freezing rain were observed throughout the County. Sussex Airport ASOS reported 0.10 inches of ice accretion.
January 26, 2021	N/A	N/A	Sussex County	Light snow and freezing rain were observed throughout the County. Sussex Airport ASOS reported 0.01 inches of ice accretion and up to 1.5 inches of snow.
January 31, 2021	N/A	N/A	Sussex County	Snow was observed throughout the County lasting several days.
February 1, 2021	N/A	N/A	Sussex County	There were several reports of 24 to 32 inches across the County during this major winter storm event. Total snowfall was over 32 inches in Andover.
February 7, 2021	N/A	N/A	Sussex County	Light snow was seen throughout the County. Heavier snowfall occurred in the southern portion. Up to 3.7 inches of snow was reported in Hopatcong.
February 9, 2021	N/A	N/A	Sussex County	Light snow was seen across the County with up to 4 inches of snowfall throughout. Township of Wantage reported 3.8 inches of snowfall.

Event Date	FEMA Declaration or State Proclamation Number	Sussex County included in declaration?	Location Impacted	Description
February 15, 2021	N/A	N/A	Sussex County	Freezing rain occurred throughout the County. Township of Wantage reported 0.38 inches of ice accretion. Sussex Airport ASOS reported 0.34 inches of ice accretion.
February 18, 2021	N/A	N/A	Sussex County	Light snow was observed throughout the County. Andover reported up to 5.6 inches of snowfall.
February 22, 2021	N/A	N/A	Sussex County	Snow fell countywide. Andover reported 4.9 inches of snowfall.
December 21, 2021	N/A	N/A	Sussex County	Freezing rain occurred throughout the County. Township of Wantage reported 0.06 inches of ice accretion. Sussex Airport ASOS reported 0.01 inches of ice accretion.
December 25, 2021	N/A	N/A	Sussex County	Freezing rain was observed throughout the County. Sussex Airport ASOS reported up to 0.03 inches of ice accretion.
December 27, 2021	N/A	N/A	Sussex County	Trace amounts of icing occurred in parts of the County. Data was compiled using radar and surface observations.
January 5, 2022 – January 9 2022	N/A	N/A	Sussex County	Freezing rain occurred over the eastern portion of the County. Up to 4 inches of snowfall was recorded countywide. Stockholm reported the highest snowfall of 4 inches. Sussex Airport ASOS reported 0.03 inches of ice accretion.
January 16, 2022	N/A	N/A	Sussex County	Snow and freezing rain fell across the County. Maximum snowfall was recorded at 7 inches in Township of Wantage. Sussex Airport ASOS reported 0.09 inches of ice.
January 28, 2022	N/A	N/A	Sussex County	Up to 5 inches of snowfall was recorded countywide. Highland Lakes reported up to 7.8 inches of snow.
February 4, 2022	N/A	N/A	Sussex County	Freezing rain was observed countywide. Township of Wantage reported 0.10 inches of ice accretion.
February 13, 2022	N/A	N/A	Sussex County	Up to 4 inches of snowfall was recorded across the County. Andover reported up to 4.4 inches of snowfall.
February 25, 2022	N/A	N/A	Sussex County	Snow and sleet were recorded across the County. A total of up to 2.5 inches of snowfall and freezing rain were observed.
March 9, 2022	N/A	N/A	Sussex County	Up to 4 inches of snowfall was seen countywide. High Point received up to 4.3 inches.
March 12, 2022	N/A	N/A	Sussex County	A range of 3 to 6 inches of snowfall was recorded across the County. High Point received up to 5.3 inches. Wind gusts were measured over 60 mph near High Point and resulted in several power outages.
March 23, 2022	N/A	N/A	Sussex County	Icing was observed in high elevations on the northern portion of the County. Up to 0.30 inches of ice accretion was seen in High Point.
November 15, 2022	N/A	N/A	Sussex County	Light snow, sleet, and freezing rain was observed countywide.

Event Date	FEMA Declaration or State Proclamation Number	Sussex County included in declaration?	Location Impacted	Description
December 11, 2022	N/A	N/A	Sussex County	Countywide coating of up to 3 inches of snowfall was observed. Township of Montague reported up to 3.8 inches of snow.
December 15, 2022	N/A	N/A	Sussex County	Up to 7 inches of snowfall was recorded in higher elevations of the County. High Point reported up to 7.2 inches. Sleet and freezing rain also occurred countywide.
December 23, 2022	N/A	N/A	Sussex County	Wind chill ranging from -10 to -20 °F was observed in the area. The lowest wind chills were recorded at the higher elevations of Sussex County.
January 23, 2023	N/A	N/A	Sussex County	Up to 3 inches of snowfall was recorded at lower elevations of the County. Higher elevations saw up to 4 inches. Stockholm reported up to 4.5 inches of snowfall.
January 25, 2023	N/A	N/A	Sussex County	Township of Sparta reported up to 1.2 inches of snowfall in a 4-mile radius.
February 3, 2023	N/A	N/A	Sussex County	Temperatures dropped to below zero across Sussex County. The combined wind conditions also resulted in dangerous wind chills ranging from -10 to -15 °F.
February 27, 2023	N/A	N/A	Sussex County	Total snow accumulations ranged from 4 to 6 inches across the County. The highest reported snow accumulation was seen in Highland Lakes and Township of Vernon at 6.9 inches. Light freezing rain and sleet was also observed.
March 7–14, 2023	N/A	N/A	Sussex County	Southern portion of the County received up to 4 inches of snowfall. Township of Sparta recorded up to 4.5 inches. High Point reported up to 7.8 inches in the start of the winter storm. By the end of the winter storm event High Point had received up to 9.3 inches of snow accumulation.

Source: NOAA NCEI 2024; FEMA 2024

17.1.4 Probability of Future Occurrences

Probability Based on Previous Occurrences

Information on previous severe winter weather occurrences in the County was used to calculate the probability of future occurrence of such events, as summarized in Table 17-4. Based on historical records and input from the Steering Committee, the probability of occurrence for severe winter weather in the County is considered “frequent.”

Table 17-4. Probability of Future Severe Winter Weather Events in Sussex County

Hazard Type	Number of Occurrences Between 1996[a] and 2024	Percent Chance of Occurring in Any Given Year
Freezing Fog	3	10.34%
Frost Freeze	2	6.90%
Heavy Snow	47	100%
Ice Storm	10	34.48%
Winter Storm	77	100%
Winter Weather	249	100%
Total	**388**	**100%**

Sources: NOAA NCEI 2024

a. Events prior to 1996 are not included because sources of earlier data are not considered to be complete.

Effect of Climate Change on Future Probability

Projections of climate change for New Jersey predict higher temperatures, more intense rainfall events, and increases in total annual precipitation (see Section 3.3.4) (NJDEP 2020). There is a lack of quantitative data to predict how future climate change will affect snowfall and ice storms in New Jersey. It is likely that the number of winter weather events will decrease and the winter weather season will shorten. However, it is also possible that the intensity of winter weather events may increase. The exact effect on winter weather is still highly uncertain (Sustainable Jersey Climate Change Adaptation Task Force 2011). Future enhancements in climate modeling will provide an improved understanding of how the climate will change and impact Sussex County.

17.1.5 Cascading Impacts on Other Hazards

The freezing and thawing of snow and ice associated with winter weather events can create major flooding issues in the County. Mitigating winter weather hazards through snow and ice removal could minimize the potential risk of flooding during a warming period. Severe winter weather events can escalate the impacts of utility failure. Ice and snow accumulation can be destructive to the functionality of utilities through falling tree branches under the weight of winter precipitations, often breaching power lines and disconnecting the utility systems.

17.2 VULNERABILITY AND IMPACT ASSESSMENT

All of Sussex County is vulnerable to severe winter weather events. Due to a lack of quantifiable loss information, a qualitative assessment was conducted to evaluate the assets exposed to this hazard and its potential impacts.

17.2.1 Life, Health, and Safety

Overall Population

The entire population of Sussex County (144,221 people) is exposed to severe winter weather events. Winter weather indirectly kills hundreds of people in the United States each year. People can die in traffic accidents on icy roads, heart attacks while shoveling snow, or hypothermia from prolonged exposure to cold.

Socially Vulnerable Population

The homeless and elderly populations are most susceptible to the severe winter weather hazard. The elderly are susceptible due to their increased risk of injuries and death from falls, overexertion, or hypothermia while clearing snow and ice. Homeless people and residents below the poverty level may not have access to housing or their housing could be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply).

Without a quantitative assessment of potential impacts of a severe winter weather on socially vulnerable populations, the Planning Partners can best assess mitigation options through an understanding of the general numbers and locations of such populations across Sussex County. Section 3.5.3 provides detailed data on socially vulnerable populations within the planning area. Table 17-5 summarizes highlights of this information. For planning purposes, it is reasonable to assume that percentages and distribution of socially vulnerable populations affected by a severe winter weather event will be similar to the countywide numbers.

Table 17-5. Distribution of Socially Vulnerable Populations by Municipality

Category	Sussex County Total		Municipality Highest in Category		Municipality Lowest in Category	
	Number	Percent	Number	Percent	Number	Percent
			Vernon (T)	Walpack (T)	Walpack (T)	Sparta (T)
Population Over 65	**25,451**	**17.65%**	**3,687**	**100.00%**	**7**	**13.38%**
			Sparta (T)	Lafayette (T)	Walpack (T)	Walpack (T)
Population Under 5	**6,500**	**4.51%**	**1,160**	**7.21%**	**0**	**0.00%**
Non-English-Speaking Population	**1,922**	**1.33%**	Hopatcong (B) **339**	Hamburg (B) **10.17%**	Andover, Frankford, Sandyston, Stanhope, Stillwater, Walpack **0**	Andover, Frankford, Sandyston, Stanhope, Stillwater, Walpack **0.00%**
Population With Disability	**15,697**	**10.88%**	Vernon (T) **2,318**	Franklin (B) **17.32%**	Walpack (T) **0**	Walpack (T) **0.00%**
Population Below Poverty Level	**7,320**	**5.08%**	Vernon (T) **877**	Sussex (B) **18.03%**	Walpack (T) **0**	Walpack (T) **0.00%**
Households Below ALICE Threshold	**14,428**	**21%**	Vernon (T) 1,833	Sussex (B0 **48%**	Branchville (B) 90	Green (T) **14%**

17.2.2 General Building Stock

The entire general building stock inventory is exposed and vulnerable to the severe winter weather hazard. Sussex County is estimated to have 71,937 buildings, with a total replacement cost value (structure and content) of approximately $68.5 billion (see Section 3.7.1).

An extreme blizzard or snowstorm event can deposit significant amounts of snow that are heavy enough to damage roofs and aging buildings. In general, the structural impacts include partial damage to roofs and building frames, rather than an entire building. Aging infrastructure could be more at risk.

17.2.3 Community Lifelines and Other Critical Facilities

Heavy accumulations of snow and ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communications and power can be disrupted for days while utility companies work to repair the extensive damage. Bridges and overpasses are particularly dangerous because they freeze before other surfaces (NWS 2019). Heavy snow can immobilize a region and paralyze a city, shutting down all air and rail transportation and disrupting medical and emergency services (NOAA 2023).

Full functionality of critical facilities such as police, fire, and medical facilities is essential for response during and after a severe winter weather event. These critical facility structures are largely constructed of concrete and masonry; therefore, they should suffer only minimal structural damage from severe winter weather events. Because power interruption can occur, backup power is recommended.

Infrastructure at risk for this hazard includes roadways that could be damaged due to the application of salt and intermittent freezing and warming conditions that can damage roads over time. Severe snowfall requires the clearing roadways and alerting citizens to dangerous conditions. Following the winter season, resources are required for road maintenance and repair of winter weather related damage, including cracks and potholes caused by freezing and plowing (NWS 2019).

17.2.4 Economy

Depending on the severity and duration of the severe winter weather event, damage to the general building stock, critical facilities, and community lifelines can include roof damage from heavy snow loads, structural damage from downed trees, and power outages.

The cost of snow and ice removal, roadway treatments (salt and brine) and repair of roads from the freeze/thaw process and plowing damages can drain local financial resources. In addition to snow removal costs, severe winter weather affects the ability of persons to commute into and out of the area for work or school. The loss of power and closure of roads prevents the commuter population traveling to work within and outside of the County and may cause a loss in economic productivity. The economic impact of winter weather each year is huge, with costs for snow removal, damage, and loss of business in the millions (NOAA 2023).

According to FEMA's National Risk Index, Sussex County's expected annual loss from ice storms is $89,000 and its expected annual loss from winter weather is $92,000 (FEMA 2019).

17.2.5 Natural, Historic and Cultural Resources

Natural

Severe winter weather can have a major impact on the environment. For example, an excess amount of snowfall and earlier warming periods may affect natural processes such as flow within water resources. The residual impacts of a community's methods of winter weather maintenance may also have an impact on the environment. (NSIDC n.d.). Road-salt runoff can cause groundwater salinization, modify the soil structure, and result in loss or reduction in lake turnover. Additionally, road salt can cause changes in the composition of aquatic invertebrate assemblages and pose threats to birds, roadside vegetation, and mammals (Tiwari and Rachlin 2018).

Rain-on-snow following winter weather events can exacerbate runoff rates. These excess volumes of water can erode banks, tear apart habitat along banks, and disrupt terrestrial plants and animals (Tiwari and Rachlin 2018).

Historic

Historic buildings may be susceptible to damage from severe winter weather conditions, especially if they were not built to modern building standards for snow loading (CCAHA 2019).

Cultural

Cultural buildings may be susceptible to damage from severe winter weather conditions, especially if they were not built to modern building standards for snow loading (CCAHA 2019).

17.3 CHANGE OF VULNERABILITY SINCE 2021 HMP

Overall, Sussex County's exposure and vulnerability have not changed, and the entire County will continue to be exposed and vulnerable to severe winter weather events. Any perceived or actual changes in vulnerability may be attributed to changes in population numbers and density.

17.4 FUTURE CHANGES THAT MAY AFFECT RISK

Understanding future changes that affect vulnerability can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The following sections examine potential conditions that may affect hazard vulnerability.

17.4.1 Potential or Planned Development

As discussed in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. All such areas of growth are vulnerable to severe winter weather. New development sites should adhere to proper building codes to protect against severe weather, such as snow-load protection.

17.4.2 Projected Changes in Population

Changes in the density of population can impact the number of persons exposed to the severe winter weather hazard. Persons that move into older buildings may increase their overall vulnerability. Those moving into newer construction may decrease their vulnerability.

The New Jersey Department of Labor and Workforce Development produced population projections by County from 2014 to 2019, 2024, 2029, and 2034. According to these projections, Sussex County is projected to have a decrease in population in the upcoming years. These projection totals include a population of 140,400 by 2024, 137,300 by 2029, and 136,600 by 2034 (State of New Jersey 2017).

Climate Change

Climate change has the potential to alter the prevalence and severity of extremes such as winter weather. While predicting changes of severe winter weather events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment (NASA 2023).

Climate change is a potential threat to cultural heritage sites as it may aggravate the physical, chemical, and biological mechanisms causing degradation by affecting the structure or composition of building materials. Changes in temperature, precipitation, and atmospheric moisture have been identified as concerns by the United Nations (Sesana, et al. 2021).